

## SURVIVAL OF LADYBIRD HOSTS INFECTED WITH PHORID PARASITIDS

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### Introduction

THE SCUTTLE-FLIES *Phalacrotophora fasciata* (Fallén) and *Phalacrotophora berolinensis* Schmitz (Diptera: Phoridae), are well known parasitoids of ladybirds in Britain (Disney *et al.* 1994). Eggs are laid on, or in, ladybird pupae, usually during, or soon after, pupation. In previous reports of these flies, emergence of fly larva from a host has invariably been associated with the death of the host. We here wish to report two observations of pupae of the 2-spot ladybird *Adalia bipunctata* (L.) producing both phorids and adult ladybirds.

### Methods

Between 24 and 29 June 1998, a sample of 730 *A. bipunctata* pupae were collected in the vicinity of Juniper Hall, Mickleham, Surrey (O.S. grid ref. TQ 173 527). The pupae were placed into individual Petri-dishes and retained in the laboratory until either phorids or adult ladybirds emerged. Phorid larvae were allowed to pupate and were weighed between 24 and 72 hours after pupation. The number of phorids from each host pupa was recorded. Thereafter, phorids were allowed to eclose and were identified as either *P. fasciata* or *P. berolinensis* (by R.H.L. Disney). Some *A. bipunctata* pupae failed to produce either adult ladybirds or phorids.

### Results

Of the sample of pupae, 168 failed to produce either ladybirds or phorids. Of the remainder, 472 produced adult *A. bipunctata*, 88 produced phorids, with successful infection levels varying between one and seven phorids, while two pupae produced both single phorid larvae and healthy adult ladybirds. In both of these latter cases, the phorid larvae emerged before the ladybird pupae eclosed.

The weights of the phorid puparia produced in these two instances were 1.0mg and 1.1mg. The weights of these two compare with a mean weight of 1.74mg of phorids from pupae producing a single larvae, and were the lightest puparia from such hosts (n=14). The adult phorids which eclosed from the two puparia were both male *P. fasciata*. The adult ladybirds which emerged from the two pupae were a female, which subsequently laid fertile eggs after mating, and a male which was mated to a virgin female that subsequently laid eggs with normal fertility rates, indicating that the interaction with phorids had not obviously affected the reproductive potential of these two hosts. The two ladybirds were not obviously smaller than other same sex adults from the pupal sample.

### Discussion

The low weight of the two phorids from host pupae which also produced adult ladybirds suggests that these phorids gained less resources than those phorids which killed their hosts. It is feasible that the ladybirds in question have some physiological mechanism which confers a degree of immunity against phorid infection by protection of nutrient resources. On the other hand, as only a single phorid emerged from each pupa, and in both cases the phorids were abnormally small, it is feasible that the drain on their hosts resources accruing from their presence was insufficient to prove fatal to their hosts.

The observations of phorid parasitisation failing to prove fatal to *A. bipunctata* pupae is unlikely to have significant consequences on the population demography of the host, because of the rarity of such events, unless novel immunity is involved and spreads. However, the observation may have importance in respect of the horizontal transmission of heritable cytoplasmic bacteria of ladybirds. These bacteria which are inherited only down the female line, kill male but not female host embryos. Phylogenetically similar bacteria have been found in different species of ladybirds. For example, similar *Rickettsia*-like bacteria have been found in both *A. bipunctata* (Werren *et al.* 1994) and in the closely related *A. decempunctata* (L.) (10-spot ladybird), the two bacteria showing over 99% sequence homology in the ITS gene (Schulenburg, *pers. comm.*). Similarly, *A. bipunctata* and *Harmonia axyrids* (Pallas), both harbour male-killing *Spiroplasmas* with >99% homology in the *wsp* gene (Hurst *et al.* 1999; Majerus, T. *pers. comm.*). The close homology of male-killing bacteria in different species suggests that horizontal transmission of the male-killers might occasionally occur, either via contagion or through some intermediate vector. The possibility that phorids might act as such a vector for male-killing bacteria has hitherto been disregarded as it was previously assumed, on the basis of literature reports and observation, that parasitisation by phorids was invariably fatal (Disney *et al.* 1994; Majerus, 1994). The observations described above make this assumption unsafe. It is possible that phorids could vector male-killing bacteria between host coccinellid species thereby causing novel invasions, as very rare events.

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